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### Ohio State Engineer

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# Speed Molding

BILL ACHBACH, Met. III

Powder metallurgy is decidedly not a new subject, but during the last few years it has developed a new significance and is demanding respect from the metallurgical and engineering professions and a wider appreciation of its important possibilities.

Powder metallurgy deals with the use of metal powders for forming solid particles by means of heat and pressure.

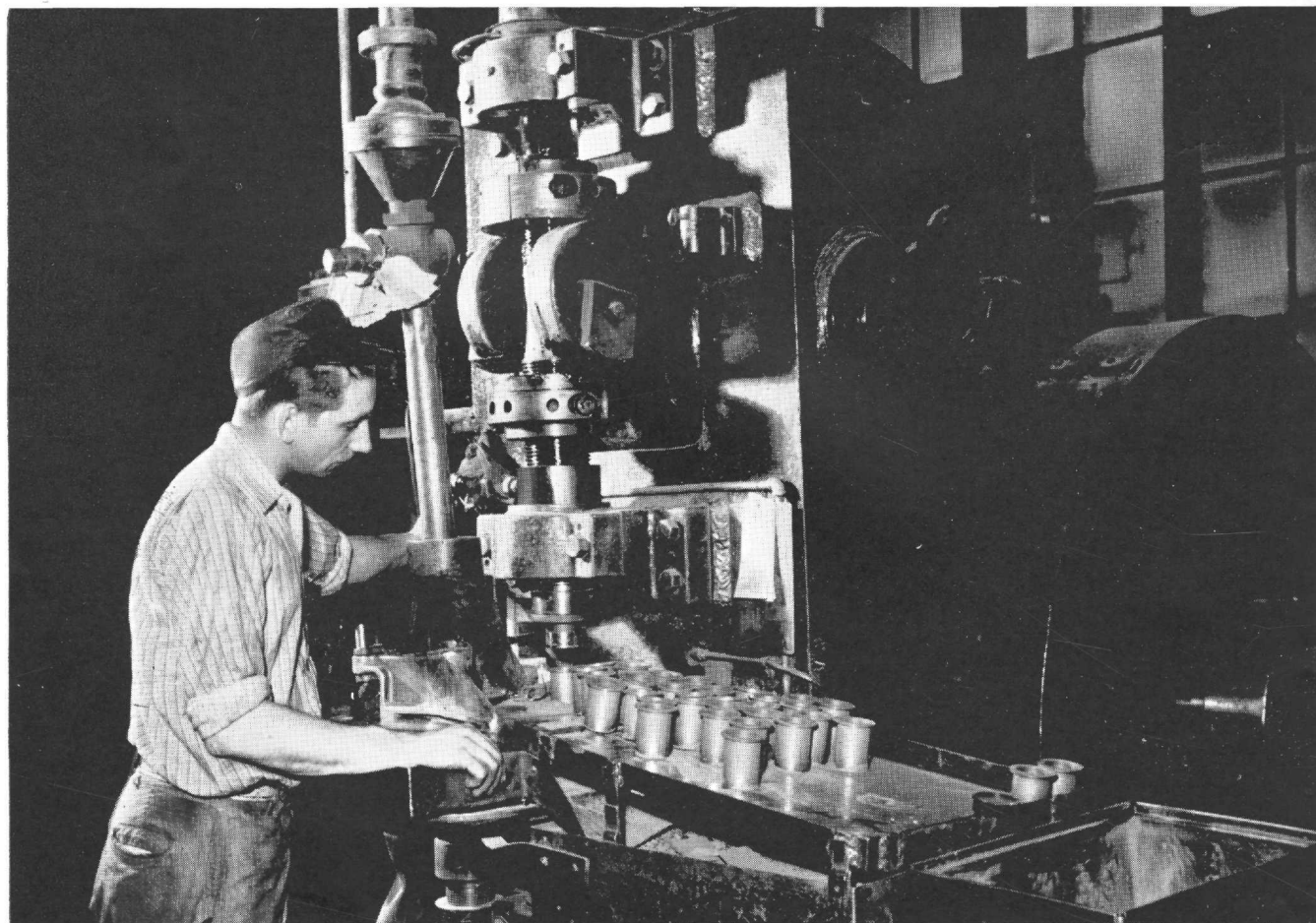
In the modern renaissance of powder metallurgy (omitting non-metallurgical uses of metal powders, such as pigments and as chemical catalysts) the first use of the sintering process was for making the filaments of incandescent electric lamps. The next stages were the production of contacts and electrode materials; porous metal bearings (a real innovation); the cemented carbides; the development of a wide range of special magnetic

materials; and finally the use of powders to make certain objects more cheaply than can be done by conventional methods of casting, working and machining.

The essential features of powder metallurgy are the production by mechanical and chemical means of a metal powder, and the consolidation of this powder at a temperature below the melting point of the major constituent into a reasonably strong solid form.

In the manufacture of tungsten metal, only two tungsten ores have commercial importance, namely wolframite,  $(\text{Fe, Mn}) \text{WO}_4$  and scheelite,  $\text{CaWO}_4$ . Its use as pure metal is due to several unique properties; foremost is its high melting temperature of  $3370^\circ\text{C}$ , the highest of any metal. Thus tungsten is the only metal now used for in-

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• In this briquetting press, the metal powder is being converted into small metal parts.

—Courtesy Aero Digest



- Offsize metal particles are sifted from the powder.

### SPEED MOLDING

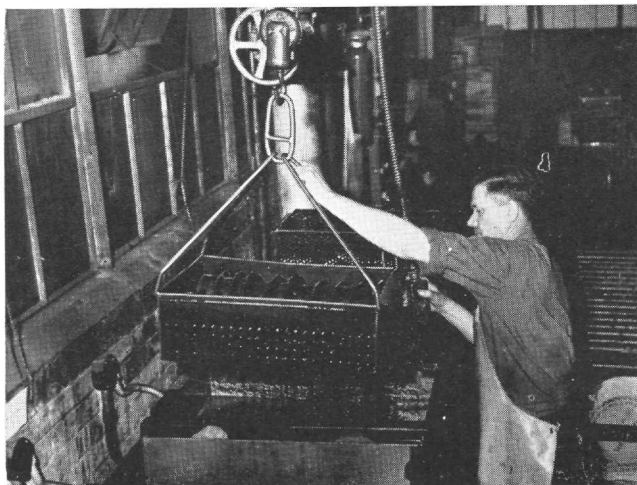
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candescent lamp filaments. It is also used as a heating element in electric furnaces in the form of both wire and tubes, in gas discharge lamps, and also in radio tubes. For X-ray electrodes the high melting point of tungsten is of great significance.

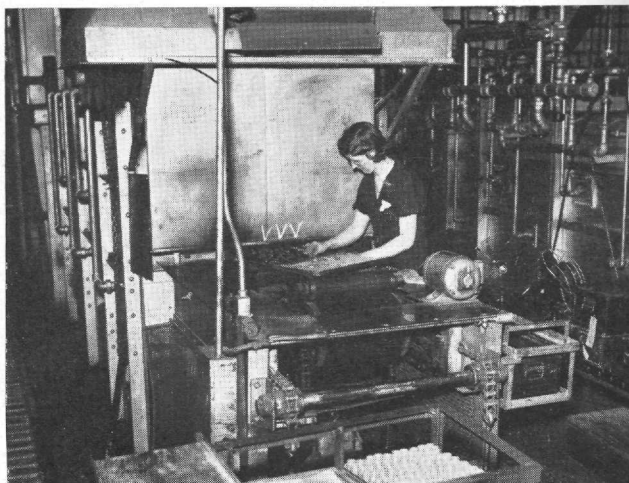
Pure tungstic oxide is prepared from the ore concentrates and then reduced to tungsten powder by hydrogen. Electrically heated tube furnaces having automatic temperature controls are used—tungstic oxide is fed through continuously and hydrogen flows in the opposite direction.

It is of great importance to protect the reduced tungsten powder from moisture; either the factory is conditioned or the powder is not exposed but manipulated in a dry gas atmosphere. Tungsten powder is then compacted in hydraulic presses. The compact is pre-sintered at 1000 to 1200°C. in an atmosphere of hydrogen to strengthen the piece so that it may be conveniently handled.

Pure metal is always reduced by hydrogen and



- Self lubricating bearings soak up oil.



- Briquetted parts going into the sintering furnace.

powder particle size depends on the type and particle size of the oxide, the impurities and additives, the temperature of reduction, the time of reduction and the moisture content.

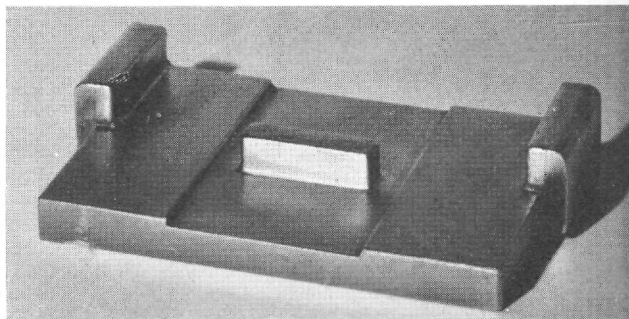
In the manufacture of tungsten wire (of vital importance today) the tungsten compacts are always sintered by passing an electric current through them, which must be controlled accurately to prevent melting at the grain boundaries of high resistance.

Since the linear shrinkage of the tungsten bar during sintering amounts to about 15 per cent, the apparent density is increased from 11 to 18 grams per cc. If a higher density is necessary, the bar is swaged.

Cold work supplies energy to the metal, and this lowers the recrystallization temperature and possibly also the range of cold brittleness. As deformation increases, therefore, the zone in which cold work can be performed moves to lower temperatures. Cold work makes tungsten more ductile instead of more brittle.

In the drawing processes carbide dies are used for diameters down to 0.3 mm.; thereafter dia-

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- A complicated milling job if machined due to the multiplicity of faces, but this metal piece is pressed out in 20 seconds to close tolerances by powder metallurgy.

—Cuts Courtesy Aero Digest



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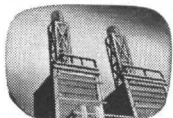
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## SPEED MOLDING

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mond dies are necessary. Drawn tungsten wire of smaller diameters made by power methods has practically the specific gravity of tungsten, 19.3 grams per cc. It has several unique properties. The tensile strength is the highest of any material and is of the order of 850,000 p. s. i.—more than twice that of the hardest steel. Also, the modulus of elasticity is extremely high, being 60,000,000 p. s. i.—twice that of steel. The linear coefficient of thermal expansion is four millionths per degree C., the lowest of any pure metal.

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